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PARKING GARAGES FOR SAN FRANCISCO

A Monograph Prepared by
Bryant Hall
Principal City Planner
June 1947

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San Francisco City Planning Commission

City and County of San Francisco

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FOREWORD

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One of the functions of the City Planning Commission, in the preparation of specific plans and programs, is that of research. Very often the results of the basic research undertaken by the Commission and its staff in the preparation of plans is of interest and of practical value in itself, entirely apart from the more specific plan of which it is an essential part.

The attached report on the economic aspects of automobile parking garages is an example of this type of research. This report, which was prepared by Mr. Bryant Hall, Principal City Planner on the staff of the Commission, will be of value to business and civic groups concerned with the problem of providing additional off-street parking facilities for automobiles. The material contained in this report was assembled over a period of many months and is being published for the information of persons concerned with this problem.

It is not the purpose of this report to present a recommended action program. Therefore, the suggestions and proposals contained in it should not be considered as final.

Michel D. Weill

Michel D. Weill, President
City Planning Commission

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PARKING GARAGES FOR SAN FRANCISCO

A Monograph prepared by Bryant Hall, Principal City Planner, 1947.

The efficiency of the private automobile in urban areas is limited, not by the capacity and power of the vehicle itself, but by the inadequacies of the streets, and the shortage of parking spaces.

Public responsibility for the improvement of streets and highways has become a matter of course. The other half of the problem, the provision of space for standing vehicles, remains unsolved. When the automobile was new, curb parking met the need well enough, but today when everyone drives, the problem of where to leave the car while working or shopping is increasingly serious. It handicaps the automobile user, and moreover threatens the economic stability of many high-valued shopping areas.

Public action has hitherto been limited to the regulation of the use of street space for parking. Some off-street facilities have been provided, mainly by private enterprise, but these have proven inadequate and unsatisfactory. The situation calls for every possible improvement in public transportation facilities, so as to lessen the need for using individual transportation. But it is also true that better provision must be made for those who will continue to drive into the central area.

The visiting shopper or client must be provided with convenient parking space, for an automobile in motion has no buying power. San Francisco cannot thrive unless its great metropolitan shopping center thrives. Hence, the responsibility of the City as a whole in this matter cannot be evaded.

A satisfactory solution, ~~based~~ upon sound principles of city planning, must be worked out. Public policies must be adopted to insure its execution. These will have to include a wide variety of remedial measures. They will involve public participation, as well as the fullest encouragement of private enterprise.

Such public policies will have to rest upon the broad basis of a many-sided approach to the general problem of urban circulation, including the careful location and design of freeways the improvement of traffic regulations and the development of the best possible public transit facilities.

The discussion of the physical and economic aspects of parking garages which follow is therefore an attempt to analyse only a single phase of this much larger problem.

Present Facilities Inadequate

The number of vehicles entering downtown San Francisco is large and increasing. It will increase more rapidly than ever, with improved efficiency of traffic arteries entering from outer parts of the Metropolitan Area. Great improvements in public transit facilities can and will be made, but a large proportion of the incoming workers, shoppers and tourists will continue to prefer to drive their own automobiles.

The drivers of most of these vehicles are destined for some point within the Central Business District. Hence they must be left standing somewhere, for some interval, short or long, while the passengers transact their business in the City. Parking facilities of various types must be ample and conveniently located, if the business center is to be accessible to all and to prosper and grow.

The amount of space available for parking is most inadequate. Curb parking, once providing for about 15,000 vehicles in the Central Business District, has been diminished by restrictions necessary for the free movement of traffic, until today it provides space for but 4,400 vehicles. Off-street parking lots provide only about 1600 stalls, and there is little prospect of any material increase of this amount, since practically all the vacant land in the District is already being used for this purpose.

There remain the commercial parking garages. These can accommodate about 7650 vehicles. Very little new construction of this type is occurring. Almost the only addition in recent years is the Union Square underground garage, which has space for 1600 cars. If each of the 13,650 spaces of all types were used an average of twice a day they would accommodate about 27,000 incoming vehicles. Double this number enter the city daily from the Bay Bridge alone. Residents of San Francisco now entering the District every morning number about 90,000. If only 1/3 of these drive in, the number of cars used would be nearly 18,000. The capacity of the proposed Bayshore Freeway will be 50,000 vehicles per day. Clearly some vigorous action to increase parking facilities is necessary.

Provision of New Parking Space

The amount and kind of new facilities required cannot be accurately estimated without a complete survey, which ought to be made as soon as the effect of abnormal war-time vehicles and usages have ceased to invalidate the conclusions. Certain general principles as to the proper location of new off-street parking spaces can be applied, according to the type of use anticipated.

It is doubtful whether individual private enterprise alone can be relied upon to solve the parking problem. The fees usually charged in commercial garages, although probably justified by experience as to cost of land, structure and operation, are such as to rule out the extension of similar accommodations to meet the whole need. Among

obvious reasons are the following:

a) Not all car operators can or are willing to pay these fees.
b) Increasing the supply, by its effect on the scale of fees collectible, tends to decrease earnings as a whole.
c) Sites are increasingly difficult and costly to secure.

The need, therefore, is to find a way in which the public as a whole, considering the important effects upon the general welfare, can bring its power to bear upon the problem so as to assist private enterprise in providing increased amounts of parking at reasonable rates.

Failing this, publicly operated parking facilities may have to be developed, as the only escape from the dilemma.

Scope of the Report

This discussion of the parking problem is concerned only incidentally with two of the three ways of increasing parking capacity for the Central Business District; curb parking and off-street parking on open lots are not given detailed study. The former is a traffic problem, or a problem in street design; the latter is limited by economic factors on high-valued land, because of the limited capacity afforded.

Parking garages, or structures providing for storage of cars above (or below) ground level constitute the third means of providing additional space for standing cars. These form the subject of the present analysis and will be considered with the following objectives in view:

a) To consider the amounts and kinds of space required, distinguishing between the needs of various types of parking, as far as these matters are determinable.

b) To examine the economics of the problem in a general way, especially as to the relation between land cost, location and size of structure, and the relative advantages of various types of structure.

c) To outline some questions of public policy, including the desirability of public action and the possibilities of using State laws recently enacted.

Amount of Space Required

The demand for parking space has never been measured for any large business center. No big city has ever made adequate provision for parking in its downtown area, hence the amount which could be usefully absorbed is entirely unknown. Still less is known as to the number of units of parking space needed of the type here under consideration--in specialized structures. Three important preliminary questions require study.

1. What fees are to be charged?

The lower the fees charged, the greater will be the patronage. If all who desired to do so could park conveniently without any charge, the space used might mount beyond all resonable proportions. For example, if this induced all workers who now daily enter the Central Business District of San Francisco to drive in, it is estimated that the area used for parking on the ground would be 430 acres (twice the size of the District). In multi-story buildings, this number of cars would actually require a total of floor space greater than the combined floor area of all existing buildings in the District. This would provide for the working population only, without allowance for shoppers, and other visitors.

Of course, if very high fees were charged, a point would be reached at which all those able or willing to pay them have been accommodated, long before the total demand for parking was satisfied. But even this amount is unkown, as the demand has generally exceeded the supply, except in times of economic depression.

2. Where will the units be located?

The total demand is further affected by the convenience of the sites chosen. The Union Square Garage never lacks patronage. But it would be useless to provide one or a dozen more like it if placed a mile away from the places people want to go.

The convenience of a location is affected too, by the kind of parking to be furnished. The distance a patron will walk from and to his car depends upon the nature of the business to be transacted. The following classes may be distinguished:

a) In and out. Vehicle used to approach a shop or office for a brief transaction requiring 5 to 15 or 20 minutes.

   Here the parking site must be within a block or so, to be really convenient. Ideally curb parking or parking on the premises should meet this need.

b) Medium-time. For transactions requiring over 20 minutes and ranging up to an hour or two. This includes treatments such as visits to doctor, dentist, barber, beauty shop, luncheon, minor shopping, business conferences, and the like.

   Walking distances up to two or three blocks would not be too inconvenient for these.

c) Long-time. For shopping tours, theater-goers, tourists, professional on-call cars, and other transactions requiring more than two hours but not usually the full day.

   Somewhat longer walking distances are allowable; just how much is not fixed. Probably 1/3 to ½ mile is the limit.

d) All-day. For workers, business men, and visitors and shoppers who prefer to use their own car to reach the District for the business day.

> Here, too, a half-mile is probably the limit of real convenience; but cheap rates offered somewhat farther out may attract patronage, especially if combined with some convenient form of local transit facility.

3. What total volume of traffic will enter the District?

A third unknown is the future total of automobiles entering the district (as a destination). What this will be depends upon the general growth of the metropolitan area, the proportion of the total business retained in the Central Business District, the relative comfort and convenience of mass transit facilities, the number and capacity of thoroughfares leading toward the District (freeways, bridges, widened streets) and traffic conditions within and around the District. All these, and especially the last, will be in turn affected by the quality and quantity of parking facilities provided.

There is no means of estimating increases in the amount of incoming traffic that would be induced by ample provision for parking, nor can we measure accurately the effect on driving of improvements contemplated in the public transit service. These uncertainties make it dangerous to base estimates of demand upon the proportion of partons now coming by automobile. The only conclusion that can be reached is that before even the present flows of traffic are relieved of serious inconvenience and delay, there is clearly much to be done, and that there is little danger of an over-supply resulting from our efforts.

The aim must be to encourage every constructive effort to supply parking space and to establish public policies favorable to the development of every suitable site.

Economic Factors of Garage Construction

Each of the items in the following simple outline for the financial analysis of any given parking facility will be briefly discussed.

1. Capital Investment
    a) Cost of Land (cleared)
    b) Cost of Structure
2. Annual Charges
    a) For interest and amortization of borrowed funds
    b) For taxes on the completed project
    c) For operation (maintenance, wages, management)
    d) For profit*(including State and Federal taxes)
3. Annual Income Anticipated (or required to meet charges)
    a) From other uses of the structure, if any
    b) From parking fees

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* Included as a charge, because when combined with the others it forms a total which may not exceed the total income.

Item 1.a) Cost of Land

For a given site, the present assessed value can easily be determined. The cost of acquisition will ordinarily vary between two and three times this amount. In assembling a large site, the owners of individual parcels may, by holding out for exorbitant prices, defeat a project, or greatly increase costs. Condemnation by the public (or by a Parking Authority) is one way in which the city might act.

Removal of existing buildings is an element of land cost. The possibility of moving, or of utilizing, some existing structures on the site may affect this item. No limiting cost per square foot of land can be established, as the kind of structure and the inclusion or exclusion of other uses such as stores, offices, or apartments will cause wide variations in the allowable expenditure.

Item 1.b) Cost of Structure (including plans, promotion and interest during construction).

For the ordinary standard types of garage buildings, estimates of construction costs are not difficult. For highly specialized designs, with low ceilings, mezzanine or staggered floor levels, latticed walls (for ventilation and economy), and column spacing adapted to maximum capacity, costs vary widely, and cannot be calculated accurately without detailed design data. It appears likely that considerable reductions in cost can be made by such means, but the specialized building may be less attractive to investors than one capable of easy conversion to other uses. The combination of the garage use with other uses, such as stores on the ground floor frontage, places limitations on the freedom of design, and will increase the cost of the structure.

Important, too, is the question of access to the garage. The design which offers a maximum capacity per dollar of construction cost may be either ideal or very undesirable from the viewpoint of the effect upon traffic conditions on nearby streets. Multiple entrances and exits add to the structural cost, and especially to the cost per stall. But a deficiency in this respect may inconvenience patrons and produce congestion on surface streets, especially during rush hours. Direct entrance from a freeway without use of surface streets may be an important advantage.

The cost of construction per stall is also materially affected by the size and shape of the site, and by the number of levels reached from the streets or directly from expressways or elevated access lanes. When costs on the site are diminished by related public construction of expressway connections, or increased by the requirement of such ways through the building, the way in which the costs are to be shared will need to be considered.

Structural costs will vary materially with the type of operation planned; whether parking is to be done by attendants, or by the

patrons themselves. In the latter case, aisles and stalls must be more generous, double parking is ruled out, and ramps, turns and directions of movement must be such as to minimize confusion to the driver who may not be familiar with the pattern. Cost of directional signs, automatic indicators of vacant stalls, and arrangements for checking vehicles in and out will be greater, especially in garages of large total capacity. In structures planned for attendant parking, these conditions are reversed, but facilities for the attendants and increased office space will be needed, and costs of operation will be greater.

Finally, costs of materials and labor vary from year to year, and estimates for future construction are particularly uncertain at this time.

Item 2a) Interest and Amortization (fixed capital charges, excluding profit)

Extremely wide variations are possible in the annual charges for interest and amortization of funds borrowed* to finance a project. For example, if the amount varies from 20% to 80% of the whole cost, the period of repayment from 20 to 30 years, and the interest rate from 2% to 6%, then annual capital charges may be as low as 0.9%, or as high as 7.0%, of the cost. On a million dollar project, this means a range of from $8,930 to $69,740 in annual charges for this purpose. Thus it is clear that the details of financing will strongly affect the scale of rentals and fees, of if these are fixed, will largely determine the feasibility of a project, by their effect upon the balance available for operation and profits.

Item 2.b) Taxes

In rough estimates, the charge for taxes, or payments in lieu thereof, may be approximated by taking about 2% of the total cost as the annual charge. This corresponds to a tax rate of $5.00 per hundred dollars of a 40% assessed valuation. It will probably be generous enough to include charges for insurance, which should be low, on the garage portions of the structure. Insurance on portions rented for other purposes can be assumed to be covered in the gross rentals of such parts.

If the land be publicly owned, a corresponding sum would be included as lease payment in lieu of taxes, or it not, would in effect be available as a subsidy to reduce parking fees.

Item 2.c) Operation

Annual charges for operation will include the cost of keeping the garage in good condition, and for lighting, utilities, the salaries

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* Even if all the money is furnished by the project owner (public or private), the amount necessary for depreciation during a given period may be considered as a debt to be extinguished, and therefore as "amortization".

of manager and workers, and the establishment of a reserve for contingencies (such as slack periods).

One source[*] estimates this at $80,000 for a three-story garage with about 1250 stalls, or $64 per stall per year, or about 18 cents per stall per day. The figure was based upon selfparking. Another source[**] places the cost of the single item of parking and delivery of cars by parking lot attendants at about 10 cents per car.

Here, as in all of the other items discussed, the possible variations are so wide as to make it difficult to set up standards for estimating. Some elements of the estimate will vary with the type of structure, some with the overall capacity and some with the type of parking as to attendance and frequency of turn-over. The estimate would therefore have to be based upon a fully detailed plan of operation for a specific structure, and on present-day wage scales.

Item 2.d) Profit

The term is here used to represent the difference between total revenue, and the sum of the charges discussed above. This balance is the gross profit, before payment of corporate income taxes, on the portion of the cost furnished by the operators of the project. If the rental and parking fee schedules are taken as fixed in the analysis, then, its value in percentage is the end result of the analysis. But if it is assumed at a given percentage, then the scale of parking fees necessary to attain it becomes the final conclusion. In this case it might be set at zero for a publicly owned undertaking, or as high[***] as 12% to attract capital when corporate income taxes are high, or where most of the cost is financed through long-term loans at much lower rates, or with public funds.

For preliminary studies of privately operated garages, the following are useful assumptions upon which to base estimates of the income necessary to finance the long-term loan and also return a reasonable profit on the operator's own investment:

1. That at least 45%, and up to 60% of the investment can be financed by a 4% loan, to be amortized in 25 years.

2. That total revenues, less operating expenses and city taxes should amount to approximately 9% of the total investment.

Under these assumptions, the profit on the operator's share will range from 11% to 13% (before State and Federal taxes), which is considered reasonable as a basis for estimates, since it must include many

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[*] Mr. E. M. Applegarth, San Francisco

[**] Downtown Business Men's Association, Los Angeles

[***] When all the other figures in a specific case for private development have been worked out so as to establish definite working estimates exact within narrow limits, a lower percentage can safely be used, since it is more certain of achievement. But in rough estimates, the profit ought to be figured generously, in order to allow for possible disadvantageous errors in the other items.

uncertain factors.

Item 3.a) Income from sources other than parking.

Here, any income from gasoline sales, lubrication or other services to cars is to be considered as a separate use, even if handled by the same operators as the garage. The question of what proportion of the ground floor and upper stories can or should be rented for other than parking purposes is, like the others raised, not answerable in general terms. For each specific project, it will depend upon the ratio of rental values to parking income per square foot; upon types of occupant likely to be available; upon the effects of such combined use upon the financial analysis. Investors and those making loans will have to judge for themselves as to the soundness of the proposal as a whole, and as to losses likely to arise from vacancies, or from fluctuations in current rentlevels, unless the whole project is based upon pre-arranged long-term leases.

Where the public is a participant (as owner of the land, or through funds loaned,or other subsidy) the propriety of these other uses will have to be determined. Can the public powers be used to assemble land, if these other private uses are included? What proportion of an enterprise must be in parking facilities to constitute fulfillment of a "public purpose"?

When land costs are high, such other uses to provide part of the revenue may prove to be the only alternative to a high schedule of parking fees. But to what extent, in any given location, is the assumption justified that the additional space will find steady tenants, without undue competitive effects upon established enterprises?

It has been claimed that a large parking garage would of itself create new shopping income by virtue of the added patrons brought into the city, but this is a somewhat doubtful premise upon which to base construction aimed at meeting the needs of those who now enter the district. In certain locations the new space would be easily absorbed in the natural course of business extensions and changes. In others, the correct uses for the large areas involved would have to be carefully studied, and perhaps only the portions close to street frontages would find ready occupancy.

In some cases special uses might be found. Amoung these are:

a) Storage space for large retail stores
b) Terminals for bus lines
c) Light industrial uses
d) Wholesale centers (such as florists)
e) Bowling alleys, and other commercial recreational facilities
f) Fire engine houses, etc.
g) Garage for fleets of commercial vehicles, such as delivry trucks, taxicabs.

The construction of a tall building whose upper stories are used for office space, or even for apartments, is also a possibility in some locations.

It is clear from these observations that the analysis of such a garage structure, in the absence of decisions by the prospective investors on these matters, is at best speculative. Only the men who are to put money into a building can decide as to the prospects of reasonable profit in offering new rental space of these types.

When these incidental revenues are actually believed to be attainable, and the analysis shows that the combination is what makes lower parking fees possible, an important question arises. Would the building show higher returns on investment (or be solvent with lower rents) if the parking feature were simply omitted? For in effect the store or office rentals are a subsidy to the parking in such cases. Provision in this way for tenants of the building, or their customers should be encouraged wherever possible, in the case of buildings hereafter constructed, and may even be required by law. But for general use,.it cannot be expected that combination structures will be voluntarily built in any adequate numbers, unless some form of public participation is involved. This would have to be of a character which makes possible such projects on sites not now available or attractive to private investors.

Item 3.b) Income from Parking Fees

The amount of income from parking fees depends upon

1. The number of stalls provided
2. The number of times each is used ("turn-over")
    - a) on regular business days
    - b) in the evenings
    - c) on Sundays
3. The schedule of fees, as related to the length of stay.

The number of stalls provided is not a simple function of the total floor space. The actual space required for the car itself varies from 125 to 190 square feet, depending upon the angle of parking and the space between adjacent cars. The space required for aisles varies, too, with the general arrangement, the total number of cars, and the method of parking (i.e., whether by attendant or driver). Space required for ramps, elevators, stairs, offices and other incidental necessities depends upon the design, the total capacity, the number of levels, the location and number of entrances and the method of operation. Variations in the ground level, and the use of portions for other than parking purposes, also affect these items. In general the gross "floor" area required per stall will range from a minimum of 160 square feet (for attendant parking on an open parking lot) to as much as 500 square feet (for customer parking in garages of normal design with four or five levels.) The development of special designs to provide the utmost economy of floor space

deserves intensive study. A design for four or five levels so carefully worked out as to average one stall for each 300 square feet (self-parking) appears possible under certain conditions.

The number of "turn-overs" (or daily uses) of each stall is a very important factor. An increase of turn-over from 1.5 to 2.0 for example, will increase total first-hour revenues by 33 1/3%. At the Union Square Garage the turnover is reported to be 1.44 (but this includes evenings and Sundays). In some locations the amount of evening and Sunday use may be almost negligible, in others, quite important. Other factors affecting turnover are the convenience of location, readiness of access and departure, ease of checking in and out, and notably the schedule of fees. Thus if all-day parking is not discouraged by a penalizing fee, or otherwise, much in-and-out business may be lost through lack of space to receive it. The cooperative merchants' enterprise in Oakland substantially increased the number of uses of each stall by delaying the hour of opening until 9:30, when most of the all-day patrons had sought other space.

The length of stay is also a factor in income. A stall used twice in a day may bring in either the fee for two single hours, or the fee for two stays of four hours. In the Union Square Garage, for instance, two uses of a stall might bring in 50 cents or as high as 85 cents, during a single day. In garages built with public assistance, there is justification for the idea that each successive 2-hour unit or fraction after the first one should be charged for at the same rate, especially if self-parking is contemplated. This would discourage the longer stays, which ought anyway to be diverted to more distant locations, where lower fees are practical.

All of these variable factors are analyzed more at length in Appendix I, in which some tables and charts are developed which clarify the way in which they are related to one another. The material presented there will be useful in the analysis of specific projects. It also furnishes the background for a study of questions of public policy. Some of these are presented on the following pages:

Some Questions of Policy

There can be little doubt that the urgency of the need for more parking garages, and the importance of their proper location with respect to major lines of traffic movement bring this entire problem within the range of the legitimate interest of the public as a whole, and of the city government as representative of the public. The question is as to what form this interest should take, and what principles and policies should govern public action.

It is a fact that the public is already in the parking business. The use of street space for standing vehicles is not an inherent right of the individual, but only a privilege customarily granted, but frequently revoked in current practice in favor of the prior rights of moving traffic. Public money has frequently been spent to widen streets, or to narrow sidewalks, merely to provide for a so-called

"parking lane". This has proven an expensive process, with limited effectiveness.

It is only an extension of this idea that is involved in the expenditure of public funds to provide such spaces in the more practical form of off-street facilities. Further, the use of parking meters on public streets, now widely practiced, establishes in principle the idea of a business relationship in which the individual user of parking space actually pays the city government for the service rendered.

In cases where the vehicle is handled or guarded by attendants, as in the ordinary garage, the operation has been looked upon as a business, and as more properly a field for private enterprise than for public action. There can be no quarrel with this point of view. A difficulty arises however when, for a variety of reasons, this operation fails to prove sufficiently attractive as a field for investment and the facilities so provided are correspondingly inadequate to meet the city's needs.

If the shortage reaches a critical stage, where the public convenience and welfare are affected, and the stability of a whole shopping center is threatened, a sound public policy must be found which will bring about a remedy. But such a policy need not involve the entrance of the public into the business of operating garages unless and until all other measures have failed.

Forms of Public Action

Some of the forms which public action might take are here briefly mentioned.

1. Land Assembly. This would involve the purchase of land out of general public funds or special district funds, either with or without the use of the power of condemnation. In this State, the parking of vehicles is specifically included as a "purpose" to which the power of condemnation will apply. It is important to note that it is doubtful whether any use of the acquired land for other purposes, such as the leasing of ground floor space for unrelated business use, would be allowable under present law.

2. Financial Aid. This might take the form of leasing publicly owned land at something less than its commercial short-term lease value, of tax exemption or reduction applied to private land used for parking facilities, or of extension of public credit to make capital available at the lowest interest rates.

3. Zoning. The provision in zoning ordinances for automobile parking as a transitional use at the edges of the smaller commercial districts has proven useful in some communities. The zoning ordinance can also provide for long-term improvement in the situation by requiring the provision of off-street parking facilities in connection with new construction, especially near large stores, theaters, and

industrial structures.

4. Building Codes. There are many who maintain that building codes make the cost of multi-story garage structures excessive, and go beyond the requirements of safety. This requires investigation, with a view to the possible allowance, within safety limits, of simpler construction with lower ceilings, open side walls and other modifications which would materially reduce the cost of these special-purpose buildings.

5. Operation. The public can and does operate parking facilities (usually on open lots) in connection with beaches, parks, etc., and can also contract for such operation. But there is little precedent for operation of public garage buildings directly by the municipality. Future extensions of the freeway system may well include public terminal facilities as integral parts thereof, as they now are included with rail, air and steamship lines.

6. Traffic regulation, parking meters. There is no doubt that the problem of off-street parking is intimately related to that of parking at the curb, and the successful operation of the former can be forwarded by the adoption of correlated policies as to the movement of traffic and the efficient use of curb parking space. Revenues from parking meters may be considerable, and should be used for the further development of off-street facilities.

7. Reducing the Demand. Better public transit service, and the careful regulation of land uses are important means of reducing the overall demand for parking facilities to manageable proportions. All-day workers, if provided with excellent transit facilities will use them in greater proportion. The use of land for such purposes as a produce terminal in close proximity to the shopping and financial center is an example of the way in which both on-street and off-street parking facilities can be needlessly over-taxed.

8. Municipal Parking Authority. Clearly needed is state legislation authorizing the establishment of a Municipal Parking Authority. Such a body could be authorized to handle the entire parking problem as a single problem. It could regulate private operations, buy land, lease or operate garage facilities, lease ground floor frontage for business uses. It would operate as a corporate body, subject to state law, and could integrate its plans with general plans developed by the City Planning Commission (the Master Plan).

The problem will never be entirely solved by any one of these methods. All or nearly all of them will have to be used in combination, and there must be an overall plan governing the process, so that what is done in each field may supplement every other. New times requre new manners, and the city cannot survive unless a way is found to adjust its facilities to the circulation requirements of the automotive age.

APPENDIX 1.

ANALYSIS OF SPACE AND COST ELEMENTS

Space Requirements.

There are well defined limitations on the number of cars that can be stored in a given area, which arise from the dimensions of the car itself, and the space needed for circulation and access. It is necessary to allow about 16 feet for the length of the vehicle (longer trucks and buses require special consideration) and about 8 feet for the width of each stall.

Cars may be parked 1) parallel to the aisle, 2) at an angle of 45°, or 3) at right angles to the aisle. All other positions are less economical than these three.

1) Parking parallel requires moving the car forward and back, and is therefore, slower, and more hazardous. Aisles must be wide, and spaces longer than 16 feet. Column spacing does not work out well.

2) Parking at Right Angles is the most economical where parking is done by attendants. The logical column spacing would be 24 feet (room for three cars side by side) and the aisle width would be the difference between 48 feet and 32 feet (two car lengths) or 16 feet. This would still require maneuvering the car back and forth. But where used for parking by the patron, it is unsatisfactory unless aisles are at least 22' wide, and this requires 216 square feet for each stall and its share of the aisle.

3) Parking at 45° is superior in several respects to either of these, and is taken as the standard in this analysis, for the following reasons:

   a. It is quicker and safer than the others (direct entrance, one backward movement in leaving).

   b. It is practical for parking by the patron.

   c. It permits interlocking of spaces (8' x 16') as shown on Plate 1, so that while some space is lost at the rear end of the car (32 square feet), the distance between aisles is reduced (saving nearly 15 square feet) as compared with right angle parking.

   d. The logical column spacing (see Plate 1) is 22.5 feet, which is economical, and allows an aisle nearly 17 feet wide.

This method requires 253 square feet for each car and its share of the aisle. It will be noted that the capacity in the actual parking aisles is less by about 1/7 than with right-angle parking. This loss is at least balanced by the reduction in operating costs made possible when the patron can readily place and withdraw his car without supervision.

Plate 1 further illustrates the resulting arrangement of space on a floor with regularly spaced columns. It gives a quick method of estimating the total number of cars that can be placed in a clear area of any given dimensions, with entrance and exit at opposite ends of one side. This total will be reduced when space is needed for ramps, added entrances and exits, or other features making the shape irregular or interfering with the circulation pattern.

The Plate also shows the advantage of selecting building dimensions so as to avoid waste in floor space. The width measured at right angles to the access aisles should have an odd number of bays, so as to use both sides of each aisle. In general, the access aisles should run the long way of the floor, with the main aisles along the short sides.

The following table shows the results, in the case of a square floor, when the number of bays range from 5 up to 45, each way:

Table 1. EFFECT OF SIZE ON EFFICIENCY OF A SQUARE GARAGE FLOOR

Self-parking at 45° angle, Columns spaced 22.5 ft. apart in each direction.

Floor space per car including access aisles only - - 253 sq. ft.
Table includes allowance for main aisles and outer rows.
No allowance for ramps or extra entrances.*

Length & Width		Stalls	Sq.Ft. per Stall	Relative Efficiency
5	112.5'	24	532	.51
7	157.5'	60	413	.66
9	202.5'	112	366	.74
11	247.5'	180	340	.80
13	292.5'	264	325	.84
15	337.5'	364	311	.87
19	427.5'	612	298	.91
25	562.5'	1104	287	.94
35	787.5'	2244	277	.98
45	1012.5'	3784	271	1.00

* Note that these often reduce the actual capacity by as much as 25%.

It is clear from the table that garages, to be efficient for self-parking, must be of generous size. In buildings of 150 feet

square or less too great a proportion of the space goes for the main aisles. Efficiency increases rapidly until at 427.5 feet square they only take up about 10% of the floor space. Above 400 feet square, the efficiency increases less rapidly, and any theoretical gain would probably be offset by the need for wider main aisles and additional ramps, to carry the loads; and by the inconvenience to patrons in walking from and to the stalls. Slightly oblong floors differ only a little in efficiency from square ones of equal area. The relative efficiency of any such floor can be calculated as follows:

Divide the length (in direction of access aisles) by 22.5 to get "L", disregarding any remainder.
Divide the width (less 22.5 feet) by 45 to get "W" which also should be a whole number.
Then - the capacity is 4WL - 8W
The floor area per stall is $\frac{\text{Area in sq. ft.}}{4WL - 8W}$
And the relative efficiency is found by comparing this figure with 271 sq. ft. (practical minimum).
As an example, suppose that a proposed garage has a rectangular floor whose dimensions are 246 by 495. If the access aisles run the long way, we have

$$L \doteq \frac{495}{22.5} = 22$$

$$W = \frac{246 - 22.5}{45} = \frac{223.5}{45} = 5$$ (with a shortage of 1.5 feet to be made up by reducing the center and the end bays to 22')

Capacity, 4 x 5 x 22 less 8 x 5 = 400 stalls
Area per stall, 121,770 ÷ 400 = 304 sq. ft.
Relative efficiency $\frac{271}{297} = .91$

The efficiency is seen to be slightly above that found in the table for a building 337.5 feet square (which has nearly the same area).

On parking lots, where column spacing is not involved, the aisles may be reduced somewhat, and on block-size parcels it may be possible to approach the ideal of one car self-parked for each 275 square feet. On the ground floor of a garage, we may similarly adopt the figure of 325 square feet, but considering the space required for access, it is estimated that each additional level will cause further reductions in efficiency, so that if, including the roof, there are "n" levels (that is, "n-1" stories), the average floor space required can be roughly expressed as (275 + 25 n) sq. ft. This has been compared with designed structures and found to check fairly well, under ordinary conditions.

Further study of the principles outlined and their application to structures of several stories should result in designs of higher efficiency, especially where access to the upper floors can be from elevated ways connecting them with freeways. If of adequate size, it may be possible to keep within a maximum of 350 square feet per stall, even with 4 or 5 levels.

Effect on Costs.

The cost per stall of land, and of the structure, is thus dependent upon the overall size and the number of levels. If we assume in all cases that the size of the project is sufficient to make applicable the floor area ratio of 275 plus 25 n, as suggested, then we can examine the effect of story-height upon the cost of land and building, per stall.

Table 2. COST PER STALL OF LAND AND GARAGE STRUCTURE

Each stall requires (275 + 25 n) sq. ft.
Construction cost, $(4 - 4/n) x (275 + 25 n) per stall.

No. of Stories	Parking Levels (n)	Floor Space Sq.Ft./Stall	Construction Cost / Stall	Land Sq.Ft. Stall	Land Cost Stall
1	2	325	$650	162.5	$162x
2	3	350	933	116.67	117x
3	4	375	1125	93.75	94x
4	5	400	1280	80.00	80x
5	6	425	1417	70.83	71x
6	7	450	1543	64.28	64x
7	8	475	1663	59.38	59x
8	9	500	1778	55.56	56x

(x = cost per sq. ft. of land)

Since our purpose is to develop the relationship between the increased capacity of higher buildings and costs as affected by the corresponding change in the floor area per stall, it will be assumed that the cost of building is the same for various sites. This cost is here assumed to be $4 per square foot of floor area, on the basis of special simplified design and construction for maximum efficiency. Then the cost for a building of "n" parking levels, or "n-1" stories since the roof is to be used for parking, will be $(4n-4) for each square foot of the site, or $(4-4/n) for each square foot of parking space. (Where n = 1, we have a parking lot, which is not here under consideration).

It will be noted that the cost of floor space per stall increases because of the increased area required, and because of the smaller proportional advantage of the extra space on the roof.

But it is a constant for a given number of stories. The cost of land, however, varies with the unit-value of land (indicated by "x"), although the amount of land required per stall diminishes as the number of stories is increased. On low-valued land, construction cost will be the deciding factor, but when land values are high the saving in site area per stall by adding stories may reduce the total cost per stall. Hence under a given set of conditions, maximum capacity and maximum economy may not be compatible, a fact which, together with the often overlooked economic disadvantage of a site that is too small, has much bearing upon the shortage of privately financed off-street facilities in areas close to the shopping centers, and the relatively high cost of parking in buildings providing several levels.

The sloping lines on the left side of Plate 2, when read in connection with the scale of unit land values at the top, illustrate this relationship graphically. The vertical drawn through any given land cost to the sloping line which corresponds with the proposed number of parking levels, intersects it opposite the total cost of land and building per stall as indicated on the vertical scale.

It may be observed that the "one-story-and roof" structure, where $n = 2$, is the cheapest (per car space) when land value is below $6; and that as the latter increases, structures of 3,4, and 5 levels offer economies. Garages with 6,7,8 or 9 levels would, under the assumptions made, cost more per stall than the 5-level structure at all land values less than $15 per square foot. This does not mean that they could not operate at a profit, under appropriate conditions, but only that fees would have to be somewhat higher*, or the rate of return somewhat lower.

The right side of the diagram (Plate 2) is intended to show the extent of these variations. The lines are based upon certain further general assumptions as to turnover and operating costs, as follows:

Turnover:

1. The sum of the evening, holiday and Sunday parking may be taken as equivalent in all to 50 week days. Thus the annual income may be taken as about 350 times the income for an average business day.

2. Allowing for both turnover and length of stay, the average business day income per stall may be taken as 2½ times the first-hour fee, called the initial fee; i.e., the "effective turnover" equals 2.5 (See Table 3). On this rough basis the annual gross income per stall will be 875 times the initial fee;

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* Or supplemented by other income, such as ground floor business leases.

Table 3. BASIS FOR ESTIMATES OF RATIO OF REVENUE PER STALL TO INITIAL FEE

Customer Parking - 1000 stalls - Fees, 30 cents per 2 hours or fraction.

	No. Stalls	No. 2-hour periods in use.	Total No. Fees Collected	Income Average Per Stall per Day	Effective Turnover
A.	1000	4	4000	$1.20	4
B.	700	4	2800		
	100	3	300		
	100	2	200		
	100	1	100		
			3400	$1.02	3.4
C.	500	4	2000		
	200	3	600		
	200	2	400		
	100	1	100		
			3100	$ .93	3.1
D.	300	4	1200		
	200	3	600		
	200	2	400		
	300	1	300		
			2500	$0.75	2.5
E.	25	6	150	(Stay of less than 2 hours each)	
	150	5	250	" " " "	
	150	4	600		
	250	3	750		
	250	2	500		
	250	1	250		
	25	0	---		
			2500	$0.75	2.5

(Distributions D or E appear more likely to occur in practice than the others)

Operating Costs

It is also necessary to make a deduction from gross revenue for the annual operating expense per stall. Correct estimates of this

are difficult, in the absence of data applicable to the conditions assumed (i.e., operator parking, varying types of structure, a wide range of total capacity). But for present purposes it may be taken as from $40 to $70 per stall per year *. Corrections may be made for other values, graphically, as shown on the chart.

The short slanting lines on Plate 2 marked 20¢, 25¢, etc., are so placed that their intersections with the horizontals representing various annual costs of operation fall directly below the correct point on the scale of Annual Net Income per stall. Hence a vertical through this intersection extended up to meet the horizontal through the scale of total costs per stall will indicate by its location on the chart the resulting rate of return (net revenue) on the whole investment, after allowing the first 2% for city taxes, or equivalent.

In the example sketched in on the chart, it is first shown that the vertical corresponding to a unit cost of land of $8.50 meets the "4-level" line at a point opposite a cost per stall of $1924. The horizontal through this value meets the 9% line at a point above $206 on the annual net income scale. (Note that this figure is actually 11% of the investment, since 2% is deducted throughout for taxes or equivalent.) The lower diagram then shows that this net income might result from a 30-cent initial fee with operating costs of $51 per stall per year. Other examples may be easily worked out, and the diagram as a whole serves to clarify the effect of a change in any one of the factors, in a given case, upon the others.

An important factor, too, is the relation just touched upon which exists between the operator's profit on his own capital and the proportion of the whole investment which is financed by a long-term loan at relatively low interest. Table 4 shows (A) how the operator's profit mounts as the loan increases from 20 to 80 percent of the whole, the terms of amortization being 4% and 25 years. Part B of the table shows, for a loan fixed at 50% of the total, that the income required to amortize the loan (and still leave a return of 11% to the operator on his half) is reduced as the terms of the loan grow more favorable. These tables are further illustrated by Plate 3, and suggest the important influence that the use of public credit might have in encouraging private enterprise in this field.

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* This latter figure would provide, for a 1000-car garage, $70,000 annually, which might be divided somewhat as follows:

Salary, Management	$ 5,000
Salaries, attendants and office help (22 averaging $2500 per year)	55,000
Light, telephone, utilities, electrical signal system, time-clock, etc.	4,000
Printing, social secruity, miscellaneous	6,000

Table 4. A. EFFECT OF PROPORTION "FINANCED" ON OPERATOR'S PROFIT OUT OF A GIVEN INCOME (9%)

Total Investment: $1,000,000; Loan Terms 4%, Amortized in 25 years. Assume $90,000 Annually Available for Interest, Amortization and Profit (9%)

Amount of loan	Cost of Loan	Balance for Profit	Operator's Profit
$200,000	$12,802	77,198	9.6%
300,000	19,203	70,797	10.1
(400,000	25,604	64,396	10.8*
(500,000	32,005	57,995	11.6*
600,000	38,406	51,594	12.9
700,000	44,807	45,193	15.0
800,000	51,208	38,792	25.0

* Here 9% Income gives 11% profit to operator (Plate 5)

B. EFFECT OF VARIATION IN TERMS OF LOAN ON INCOME REQUIRED TO PAY 11% TO OPERATOR

Total Investment $1,000,000; Amount Borrowed $500,000

Term of Loan	Rate of Interest	Cost of Loan	11% to Operator	Total Required
20 years	6%	$43,592	55,000	$98,592
(20 years	4%	36,791	55,000	91,791**
(25 years	4%	32,005	55,000	87,005**
.	2%	25,610	55,000	80,610
30 years	2%	22,325	55,000	77,325

** Here 11% requires 9% income

APPENDIX II.

SOME NOTES ON A SPECIFIC PROJECT

The establishment of a series of garages between Minna and Natoma Streets, served by elevated roadways connected to the Bay Bridge on the east and to the Bayshore Freeway leading south from about 8th Street, has long been advocated by students of the off-street parking problem here. While its successful operation is largely dependent upon decisions still to be made as to the freeway approaches, an examination of the economics of a garage unit in this location may be made, to illustrate the process outlined in the body of this report.

The conclusions reached must be considered as purely illustrative, and subject to the assumptions made which are as follows:

1. The elevated roadways are otherwise financed, and provide access directly to the third and fourth levels.
2. The garage building is designed for self-parking, on the second, third and fourth floors, on the roof, and on the interior portion of the ground floor, which is over 100 feet from the frontage on numbered cross streets.
3. The cost of cleared land is assumed to average $8.50 per square foot.
4. The cost of the structure is assumed to be, for the ground floor (including the areas rented as stores) $6 per sq. ft., and for the upper floors, $4 per sq. ft. These figures are probably low.
5. The building is assumed to extend from one numbered street to the next, and to have a floor area of 155' x 800', or 124,000 square feet.
6. The frontage on the numbered streets is assumed to be rented for store space, etc. at an average of $15 per front foot per month.
7. The parking fee is assumed to be 25 cents for each two hours, and the average income per stall per business day, 62½ cents; per year $218.75 (350 times the business day income).

Cost Estimates

Land, cleared	124000 sq. ft. @ $8.50	$1,054,000
Structure	124000 sq. ft. @ 18.00 (4 stories)	$2,232,000
	Total	$3,286,000

Capacity

Total Floor and Roof Area	124,000 x 5	620,000 sq. ft.
less Area rented for stores	310 x 100	31,000
	Net for garage	589,000 sq. ft.

With elevated access to reduce ramp requirements, estimate the number of square feet per stall at	346 sq. ft.
Number of stalls available	1,700
Number of cars (or fees) per day at 2.5 per stall	4,250

Fixed Charges

Taxes (or equivalent) at 2%	$65,700
Maintenance and operation 1700 stalls @ $50 per year.	85,000
Amortization of Land Cost @ 4.46% (use of public credit assumed at this point, to allow for 2% interest, 30 year term)	47,000
Total	$197,700

Income

From stores, etc. - 310 front feet @ $180	$ 55,800
From garages, 1700 stalls @ $218.75	371,900
Total	$427,700

Revenue

Annual income less fixed charges,	$230,000

Then, the rate of return, after taxes, on the structure alone, which costs $2,232,000, would be 10.3%. But if the private enterprise carries the land cost as well, the revenue would be $277,000, and the rate of return on $3,286,000 would be 8.4% (after taxes). In the latter case, Plate 3 shows that an amortized loan of 45% of the total investment (25 years - 4%) would leave a profit on the remainder of about 10%.

Effect of adding 3 floors

It is of interest to examine the effect of adding 3 stories to such a building.

This would increase the floor space by -	372,000 sq. ft.
making the total garage area	992,000 sq. ft.

But, because of additional ramp space required, at least 450 square feet per car must be allowed, so that the new capacity would be 2200 stalls.

The gross revenue, @ $218.75 per stall would be	$481,250
Plus store rentals, as before	55,800
Total	$537,050

Cost of Land, as before	$1,054,000		
Cost of structure, increased to	$3,720,000	(124,000 @ $30)	
Total	$4,774,000		
Taxes, @ 2%	95,500		
Operation, reduced to $40	88,000		
Amortization of land, as before	47,000		
Total	$230,500		$230,500
Annual income, less fixed charges			$306,550

The rate of return on the building alone is reduced to 8.2%, and if the private enterprise carried the land cost as well, the revenue would be $353,550, but the rate of return on $4,774,000 would be only 7.4%.

Notes on Overall Capacity of the Project

From the above it is seen that no increase in profit can be expected to result from such an increase in the number of levels. The capacity would be increased, but there would be less assurance of maintaining the assumed average "turnover", and the question of congestion at the exits at peak hours at the end of the day would also have to be considered. If, for example, only half as many as the full garage could contain were to attempt to leave between 5:10 and 5:30 p.m., the outflow would be at the rate of 3300 cars per hour, which exceeds the capacity of two freeway lanes. This is from a single structure. If there were five such 8-level garages between Third and Eighth Streets, the outflow during that period would require 11 lanes of freeway capacity. Since all freeways leading away from the area would be carrying at that hour heavy loads from other sources, it appears that some moderation must be exercised in proposals for garage space in this particular locality; especially as allowance must be made for the desirability of constructing similar facilities in other areas. As a practical matter, it might be desirable to utilize "interior" land and exclude some of the more expensive frontage from this project

and so plan the whole as to provide for a maximum of about 7500 stalls,* in a number of separate structures of 3 to 5 stories, all connected to the freeway approaches.

Financing of the Approaches

A Parking Authority might be able to contribute to the cost of the approaches through revenue bonds; temporarily increasing the cost of parking by 10 or 15 cents to retire the bonds. This possibility should be investigated thoroughly and considered in drafting legislation.

Such an Authority could also enter into arrangements for taller buildings, the upper stories of which would be devoted to other uses, and it could work out plans for inter-urban bus terminals, a central terminal for airport services and other features involving complex negotiations and contractual relationships.

It is recommended that all these matters be examined as part of the general problem of circulation and transportation, in order that a comprehensive solution may be worked out in which this project is properly related to other features of the Master Plan.

Bryant Hall
Principal City Planner
June, 1947

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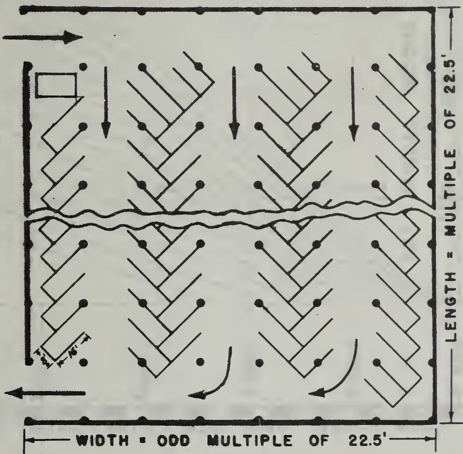
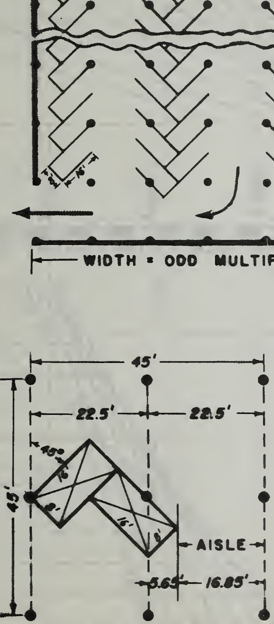
* Note that this means actually that some 18,000 patrons would be accommodated daily under the assumptions made.

BASIC ARRANGEMENT OF FLOOR SPACE
FOR 45° SELF-PARKING ON FLOOR WITH BAYS 22.5' SQ.

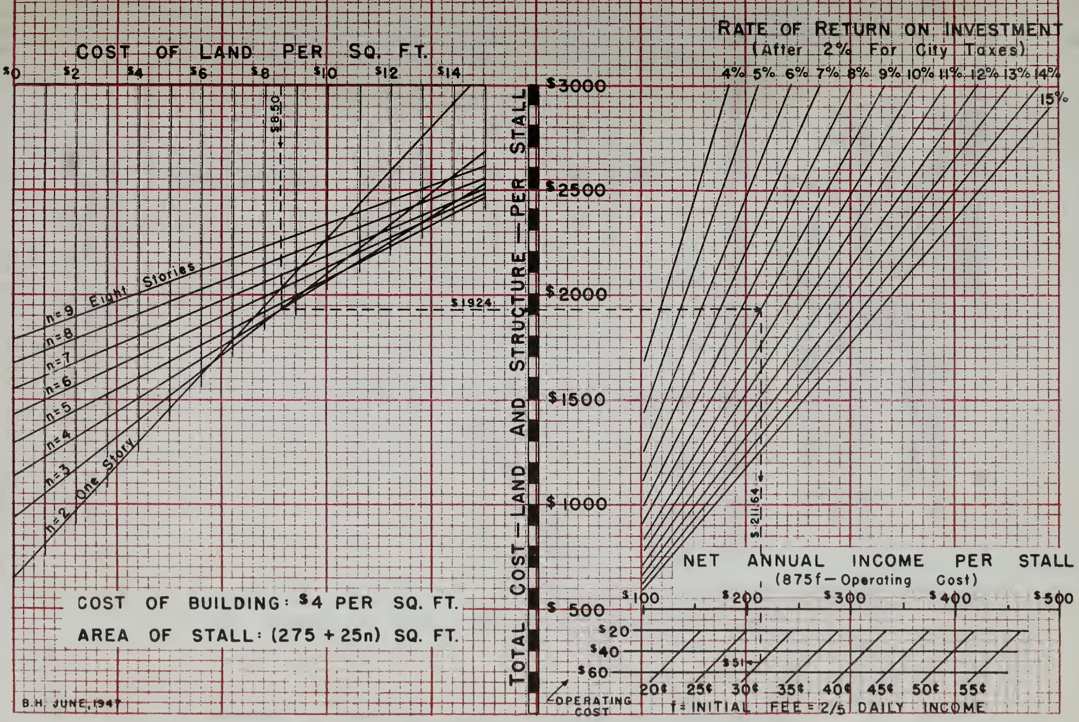




DETAIL SHOWING THE RELATION BETWEEN COLUMN SPACING AND PARKING STALL.

RULE FOR CAPACITY:
$4WL - 8W$
where W = no. of aisles
and L = length ÷ 22.5
(NO ALLOWANCE FOR RAMPS)

PLATE I

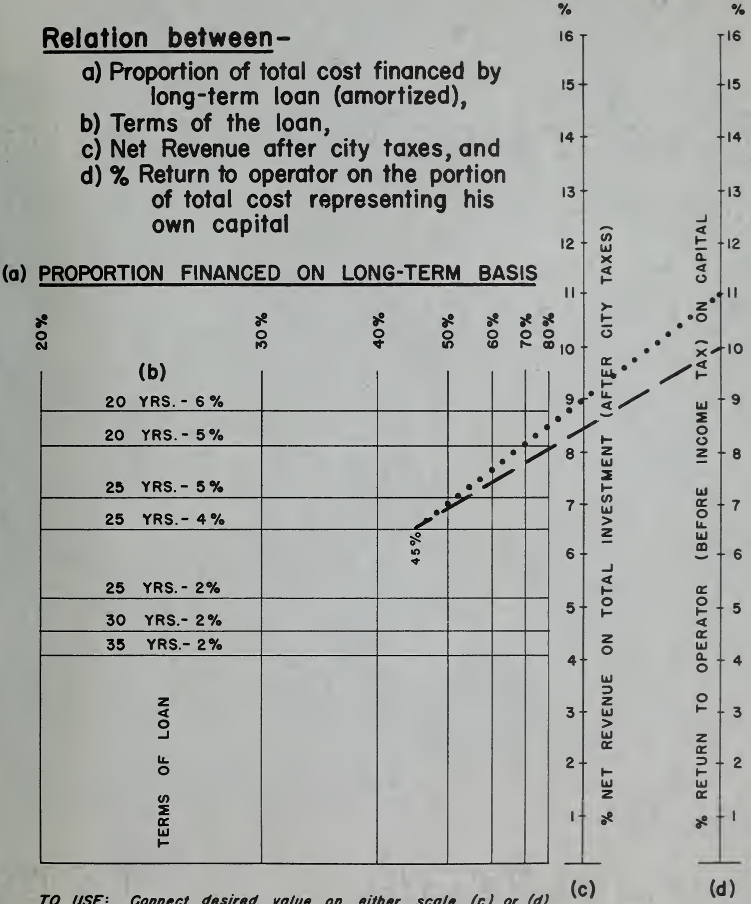


RELATIONSHIP OF LAND COST, NUMBER OF LEVELS AND FEES TO NET INCOME

SAN FRANCISCO CITY PLANNING COMMISSION PLATE 2

Relation between—

a) Proportion of total cost financed by long-term loan (amortized),
b) Terms of the loan,
c) Net Revenue after city taxes, and
d) % Return to operator on the portion of total cost representing his own capital



TO USE: Connect desired value on either scale (c) or (d) to appropriate intersection in left portion of chart, and read on the other vertical scale.

PLATE 3